Affiliated Engineers, Inc.

Gainesville Florida

COORDINATED ENERGY STUDY

EXECUTIVE SUMMARY
VOLUME 1

DWIGHT D. EISENHOWER ARMY

MEDICAL CENTER

FORT GORDON, GEORGIA

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EXECUTIVE SUMMARY

The results of the energy engineering analysis performed at Dwight David Eisenhower Army Medical Center (DDEAMC), located in Fort Gordon, Georgia are summarized herein. The work was performed by Affiliated Engineers, Inc. for the Army Corps of Engineers, Savannah District, under Army Contract No. DACA21-83-C-0188. The project included a detailed energy audit of the hospital and energy support facilities, development of a utility metering plan, and investigation of numerous energy conservation measures. Energy analyses were performed with the assistance of the ESP-II energy simulation computer program developed by Automated Procedures for Engineering Consultants (APEC). The energy conservation analysis showed that the opportunities for the most energy savings resulted from the installation of an Energy Monitoring and Control System (EMCS) and from modifications to the central plant chilled water systems. It was found that additional savings were available by upgrading miscellaneous thermal and electrical systems for greater energy efficiency. Finally, implementation documentation was developed for the various Energy Conservation Investment Programs (ECIP) and other energy conservation projects that met Army criteria.

DDEAMC includes the Hospital (Bldg. 300) two Medical Barracks (Bldgs. 315 & 317), and Administration Building (BLdg. 319), the Dental Clinic (Bldg. 320), the Dental Laboratory (Bldg. 322), the Central Heating/Cooling Plant (Bldg. 310), and twelve wood frame buildings (Bldgs. 330, 332, 333, 334, 335, 352, 353, 354, 355, 356, 376 and 377). Of these, Buildings 300, 315, 317, 319, 320, 322 and 310 are of permanent construction and the twelve wood frame buildings are of temporary construction.

The steam system consists of three boilers in Bldg. 310 which supply Bldgs. 300, 315, 317, 319 and 320. Building 322 is supplied by its own boiler, and Building 352 houses a boiler which supplies steam to the other wood frame buildings.

The chilled water system consists of a steam turbine-driven centrifugal chiller and two absorption chillers (one of these being in "piggyback" with the centrifugal) which serve Bldgs. 300, 315, 317 and 319. Building 320 is served by an air- cooled reciprocating chiller, and Bldg. 322 is served by a water-cooled reciprocating chiller. There are no provisions for chilled water in the wood frame buildings.

Present or "Baseline" energy consumption was established from the output of the ESP-II "As Operated" computer simulation. This baseline energy consumption was determined to be 333,008 MMBTU/Yr. This equates to be an annual baseline energy cost of $1,212,062. Table ES-1 (Pg. 1-13) gives the baseline annual raw source energy consumption in terms of quantity, energy units (MMBTU/Yr.), and dollars.

A breakout of the site and source energy is shown on Fig. ES-1 (Pg. 1-14) and Fig. ES.-2 (Pg. 1-15) respectively, as a percentage of the overall consumption. These figures indicate that the majority of the natural gas consumption is used to produce steam which is in turn used to provide mostly facility cooling and heating.

An extensive list of potential energy conservation opportunities (ECO's) was included in the scope of work. These were supplemented with other ECO's. A cursory examination of all ECO's was performed to determine which were

functionally applicable to DDEAMC. For those ECO's identified as worthy of further consideration, an ECO designation was assigned. The following is a list of all the ECO's considered. (Note: References made to the "wood frame buildings" are referring to Bldgs. 330, 332, 333, 334, 335, 353, 354, 355, 356, 376, and 377).

ECO's Considered

ECO Designation	Description
H-1:	Install an air-to-air heat exchanger in Bldg. 322, between the exhaust duct from the dental lab hoods and the outdoor air make-up for AHU's.
H-2:	Install an air-to-air heat exchanger in Bldg. 300 between the 38" exhaust duct from the Pathology Lab and the outdoor air make-up for AHU-4.
H-3:	Install an air-to-air heat exchanger with chemical wash in Bldg. 300 (3rd Floor) between the kitchen exhaust duct and the kitchen hood make-up air duct.
H-4:	Install a run-around heat recovery system in Bldg. 300 (3rd) between the general exhaust air streams, and outdoor air make-up to surgery and medical and non-medical holding.

H-5: Install a 60" conc. duct below grade connecting the exhaust duct from EF-6 to the intake duct for SF-6 to allow for air recirculation in the 100% O.A. system.

H-6: Install a 48" return duct in the Bldg. 300 5th floor ceiling connecting the EF-5 exhaust duct and the intake duct to SF-5 to allow for recirculation air in this 100% O.A. system.

I-1: Install sprayed-on ext. insulation on Bldg. 319.

I-2: Install sprayed-on ext. insulation on Bldgs. 315 & 317.

I-3: Remove exist. duct insulation, repair leaking ductwork, and reinsulate in Bldgs. 320 & 322.

I-4: Repair and reinsulate the low pressure heating and A/C ductwork in the wood frame buildings.

I-5: Add additional ceiling insulation in the wood frame buildings.

D-1: Install curtain-type, plastic strip doors on the west side of the 3rd floor of Bldg. 300.

D-2: Install fenestral treatment in Bldg. 319 to reduce infiltration.

D-3: Install double-pane windows, storm windows, weather stripping, and caulking in the wood frame buildings.

D-4: Install vestibules at personnel entrances to Bldgs. 300, 315, 317, 320 and 322.

D-5: Install solar shading or screening on the windows in Bldgs. 315 and 317.

S-1: Install two-position shut-off valves in steam branch supply lines that service end use points having regular periods of non-use in Bldgs. 300 & 322.

S-2: Install a waste heat recovery boiler on the two Pathological incinerators in Bldg. 300 to provide 125 psig. steam to the main steam header in the central plant (Bldg. 310).

S-3: Install insulation on the absorption condensate return tank and the plant heating and auxiliary system condensate return system in Bldg. 310.

S-4: Install ductwork to allow boiler forced draft fans to draw boiler make-up air from the stratified layer of dry, heated air near the

top of the boiler plant (Bldg. 310) in order to increase boiler efficiency.

S-5: Install a blowdown separator in Bldg. 310 to recover flash steam presently being vented to the atmosphere, and return the recovered steam to the deareator tank.

S-6: Repair leaking steam safety valves at each of the three (3) boilers in Bldg. 310.

S-7: Repair steam leaks at slip-type expansion joints and repair steam pipe insulation in the wood frame buildings.

S-8: Reduce boiler plant (Bldg 310) steam header pressure to reduce steam piping heat loss, increase boiler efficiency, and reduce power required to drive the boiler feedwater pumps.

S-9 Install an economizer on the steam boiler in Bldg. 352.

S-10 Provide for shutdown of the steam boiler in Bldg. 352 during periods of minimum use, and install point-of-use steam generators for washers and sterilizers.

S-11 Install a blowdown separator in Bldg. 352 to recover flash steam presently being vented

to the atmosphere, and return the recovered steam to the deareator tank.

C-1: Install an energy monitoring and control system (EMCS) with a central computer to control and optimize the HVAC systems in all the permanent buildings in the DDEAMC complex.

C-2: Install time clocks in the wood frame buildings to shutdown all energy-using systems during periods of non-use.

C-3: Retrofit selected constant volume reheat control zones in Bldg. 300 with variable volume control.

C-4 Install two-position shutoff dampers, required ductwork and air handling unit modifications, and associated controls in Bldg. 300 to provide for shutdown of areas with less than 24 hr/day occupancy during unoccupied periods.

C-5: Rebalance air systems in Bldg. 300 so that outdoor air quantities are in accordance with current criteria.

P-1: Install flow restrictors in Bldg. 300 bathroom hot water outlets.

P-2:	Install variable frequency drives on the existing constant-volume chilled water supply pumps in Bldg. 300, and retrofit the existing three-way chilled water control valves with two-way valves.
L-1 & L-2:	Retrofit existing exterior mercury vapor area lighting with high-pressure sodium fixtures. Also, retrofit existing fluorescent troffer lights with electronic ballasts and energy-saving lamps as existing ballast and lamp failures occur.
CW-1:	Replace the existing steam turbine drive for centrifugal chiller CH-2 (Bldg. 310) with a 600 HP electric motor.
CW-2:	Retrofit the chiller plant, Bldg. 310, incorporating both ECO's P-2 and CW-1.
CW-3:	Replace the existing absorption chiller CH-1 (Bldg. 310) with an electric-driven, hermetic, centrifugal chiller while incorporating ECO CW-1.
CW-4:	Replace the turbine-powered centrifugal chiller/absorption chiller (CH-2/CH-1) "Piggyback" combination with a single electric-driven, hermetic, centrifugal chiller.
CW-5:	Retrofit the chiller plant, Bldg. 310,

incorporating both ECO's CW-3 and P-2.

CW-6: Retrofit the chiller plant, Bldg. 310, incorporating both ECO's CW-4 and P-2.

CW-7 Retrofit the chiller plant, Bldg 310, incorporating ECO CW-5 and providing peak electrical demand shaving with a 3MW emergency (diesel) generator.

CW-8: Retrofit centrifugal chiller CH-2 with a turbine-driven combination induction generator/centrifugal chiller for peak shaving; replace the absorption chiller CH-1 with an electric-driven, hermetic, centrifugal chiller; and incorporate ECO P-2.

Energy and Life Cycle Cost Analyses (LCCA) were performed on all of these ECO's to determine feasiblilty and conformance with Army criteria for the variety of energy conservation project funding available. Of these ECO's, projects I-3, I-4, I-5, D-2, D-3, D-4, S-9, C-2 and C-3 were eliminated from consideration after qualitative analyses based on engineering judgement and "first cut" payback calculations.

Several of these ECO's were lumped together to form four (4) ECIP's. ECIP-1 involves the installation of an EMCS and includes ECO's C-1 and C-4. Modifications to the central chilled water system were included in ECIP-2 which incorporated ECO CW-3. ECIP-3 is comprised of electrical system modifications and incorporates ECO's L-1, L-2 and P-2. Finally, ECIP-4 is made up of several projects to upgrade the

various thermal systems. The ECO's included in this project were: H-1, H-2, H-3, H-5, H-6, S-1, S-2, S-4, P-1 and D-1.

Analysis indicated that the following projects qualify for implementation under QRIP guidelines: S-3, S-5, S-7, S-8, S-10, S-11 and C-5.

Several ECO's which would qualify for implementation are not being recommended because alternative ECO's were selected. These included CW-1, CW-2, CW-4, CW-5, CW-6, CW-7 and CW-8 which are alternatives to CW-3; and H-4 which is an alternative to H-5.

The field survey at DDEAMC indicated that present operational policies at the facility are quite good. Any deficiencies that were noted have all been incorporated into the various ECO's. Therefore, no specific policy changes are being recommended.

The total potential energy and cost savings that could be realized as a result of the implementation of all of the recommended ECO's and ECIP's were obtained from the output of the ESP-II "after ECO implementation" computer simulation. This simulation indicates that a total energy savings of 143,379 MMBtu/Yr. can be realized. This equates to a total annual cost savings of $435,302 per year after ECO implementation. What these savings represent is a 43% reduction in overall energy consumption. Table ES-2 (Pg. 16) gives a breakdown of the projected raw source energy consumption for the present "baseline" operation, for only implementation of airside rebalancing to meet current criteria, and for consumption after all recommended ECO's have been implemented. Table ES-3 (Pg. 17) presents projected raw source energy costs for the facility assuming an ECO implementation

schedule as presented below. Also presented for comparison in Table ES-3 are the historical energy consumption costs as obtained during the field survey.

Fiscal Year	Measures Completed
'84	1. Correction of erroneous natural gas metering.
'85	1. Bldg. 300 airside rebalancing and reduction of outside air intake in accordance with current criteria.
'88	1. Completion of: ECIP #1 - EMCS System; ECIP #2 - Chilled Water System; ECIP #3 - Electrical Modifications; and ECIP #4 - Misc. Thermal Systems Upgrade.

Because during the time span of this study no other energy conservation projects were anticipated by the hospital, the facility's energy consumption will remain at the baseline usage without implementation of some or all of the projects recommended.

Table ES-4 (Pg. 18) gives a breakdown of the ECIP projects, prioritizing them by SIR and including construction costs, annual energy savings, and annual cost savings. Below is a listing of the remaining recommended ECO's with construction costs and SIR.

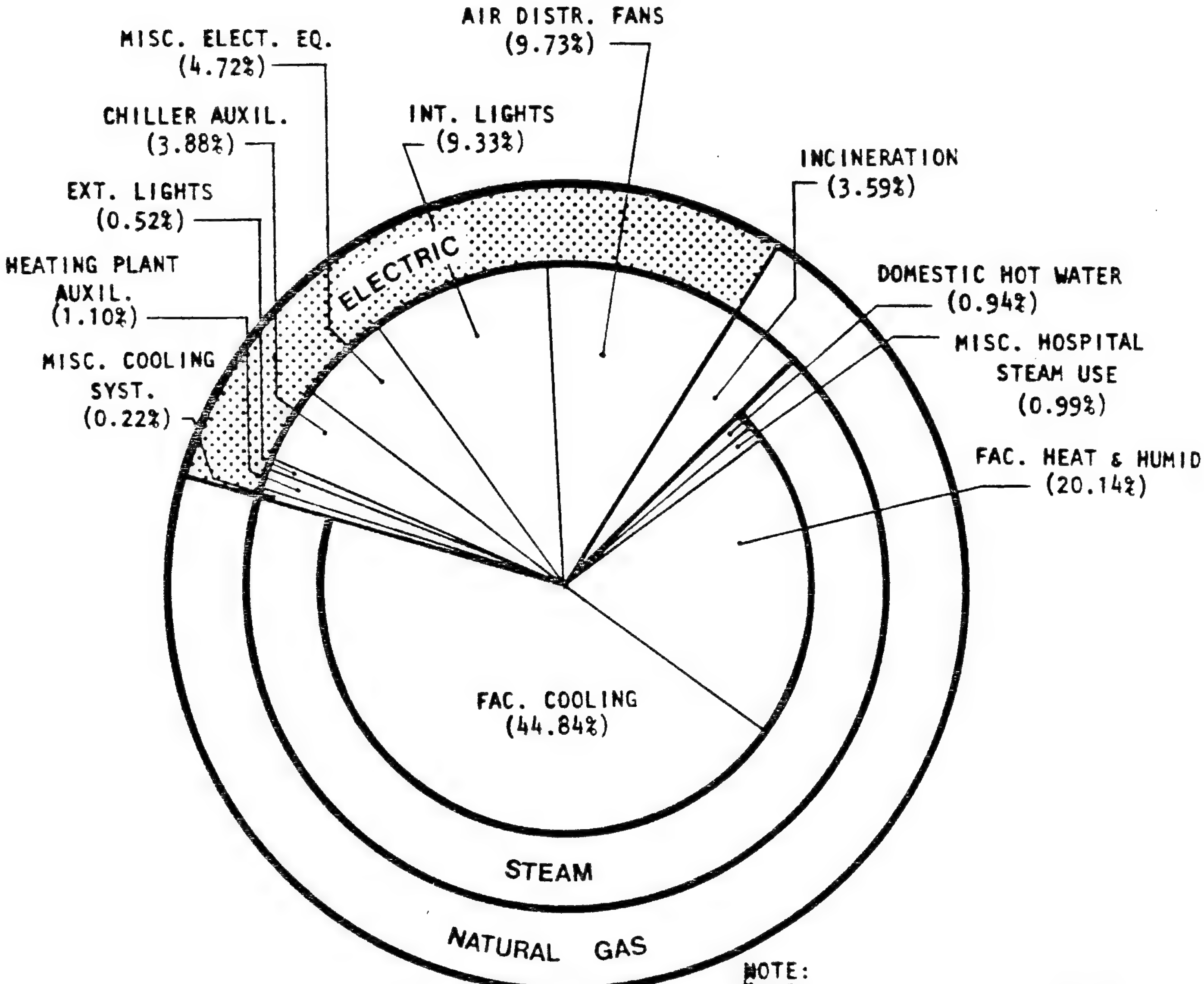
ECO DESIGNATION	SIR RANKING	CONSTRUCTION COSTS
S-8	00	$ -0-
S-10	37.24	13,119.10
S-3	24.44	398.16
S-5	15.45	3,121.78
C-5	11.26	56,963.70
S-7	9.44	29,603.30
S-11	5.75	3,000.00

Finally, in accordance with the project scope of work, a detailed metering plan was completed. The metering plan was submitted in final form in January, 1984. The documents submitted included an Executive Summary, a verbatim copy in of which is included herein on Pages Exhibit 1-1 through 1-6, with only the original page numbers and table numbers changes.

TABLE ES-1

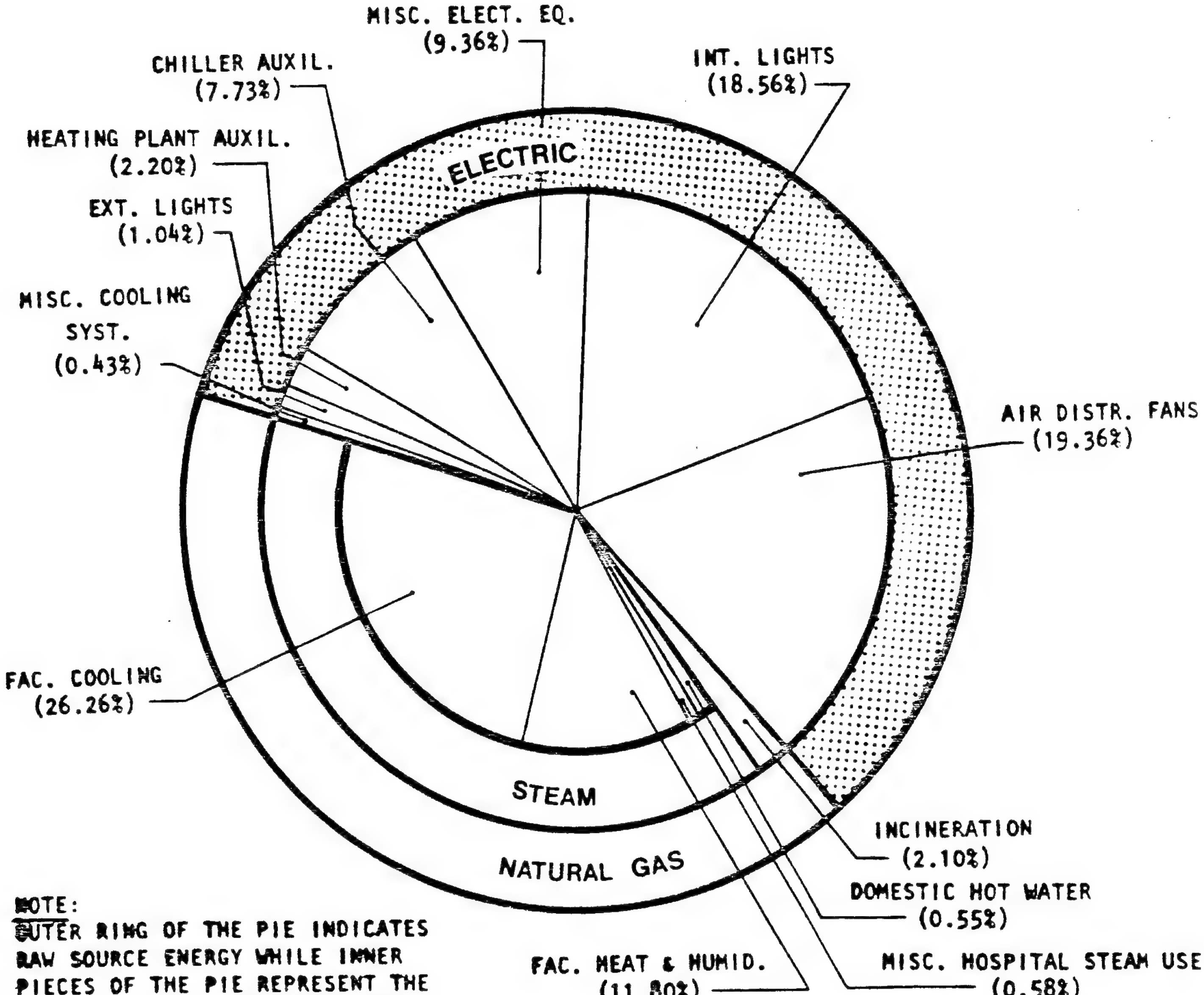
PRESENT ANNUAL CONSUMPTION OF RAW SOURCE ENERGY

UNITS	ANNUAL RAW SOURCE ENERGY CONSUMPTION		
	ELECTRICAL	NATURAL GAS	TOTAL
QUANTITY	16,854,914 KWH	1,374,910 THERMS	---
ENERGY	195,517 MMBTU	137,491 MMBTU	333,008 MMBTU
COST	$691,435	$520,627	$1,212,062



NOTE:
OUTER RING OF THE PIE INDICATES RAW SOURCE ENERGY WHILE INNER PIECES OF THE PIE REPRESENT THE DISTRIBUTION OF THAT RAW SOURCE ENERGY; I.E., FOR FIG. ES-1 ALL STEAM IS PRODUCED FROM NATURAL GAS AND STEAM IS USED TO PROVIDE ALL OF THE FACILITIES COOLING (44.84% OF TOTAL RAW SOURCE ENERGY CONSUMED).

AS OPERATED SIMULATION
FUNCTIONAL SYSTEM SITE ENERGY DISTRIBUTION
FIG. ES-1



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AS OPERATED SIMULATION
FUNCTIONAL SYSTEM SOURCE ENERGY DISTRIBUTION
FIG. ES-2

TABLE

SIMULATION	BUILDING NO.	
		ELECTRIC
ACTUAL OPERATION	300	152,69
	310 Auxil. & Incinerator	33,04
	315 & 317	4,88
	319	1,45
	Site Lighting	3,45
	Total	195,51
IAW CURRENT CRITERIA	300	152,69
	310 Auxil. & Incinerator	33,04
	315 & 317	4,88
	319	1,45
	Site Lighting	3,45
	Total	195,51
AFTER ECO IMPLEMENTATION	300	142,26
	310 Auxil. & Incinerator	21,19
	315 & 317	5,57
	319	1,30
	Site Lighting	3,45
	Total	173,78

NOTE: Raw energy transfo
delivered to the c
water has been all

①

TABLE ES-2 SIMULATED RAW SOURCE ENERGY DISTRIBUTION

PROJECTED ENERGY USE (MMBtu)		
ELECTRICAL	NATURAL GAS	TOTAL
152,690	125,427	278,117
33,042	7,008	40,050
4,882	4,174	9,056
1,451	882	2,333
3,452	-0-	3,452
195,517	137,491	333,008
152,690	92,683	245,373
33,042	7,008	40,050
4,882	4,347	9,229
1,451	372	1,823
3,452	-0-	3,452
195,517	104,410	299,927
142,266	12,714	154,980
21,192	Negligible	21,192
5,571	2,896	8,467
1,302	236	1,538
3,452	-0-	3,452
173,783	15,846	189,629

nergy transformed in Bldg. 310 (Central Plant) but
ered to the other buildings as steam and chilled
has been allocated to those buildings.

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FY	CURRENT AND P
	ELECTRICAL
'81	541.258
'82	685.159
'83	693.843
'84	691.435
'85	741.107
'86	746.110
'87	742.248
'88	702.389
'89	698.039

NOTE: Projected costs for FY '85 througt
D.O.E. fuel cost escalation rates

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TABLE ES-3: CURRENT AND PROJECTED ENERGY COSTS

⌇ENT AND PROJECTED COSTS ($000'S)		
	NATURAL GAS	REMARKS
		HISTORICAL DATA
	1,028.527	HISTORICAL DATA
	1,054.075	HISTORICAL DATA
	520.627	PROJECTED DATA
	451.170	PROJECTED DATA
	456.880	PROJECTED DATA
	479.948	PROJECTED DATA
	250.759	PROJECTED DATA
	78.721	PROJECTED DATA

35 through '89 have been escalated according to
ion rates found in NBS Handbook 135.

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TABLE ES-4: DDEAMC ECIP PROJECTS PRIORITIZED BY SIR

	DESCRIPTION	CONSTRUCTION COST $	ENERGY SAVINGS				SIR
			ELECT. MMBTU/YR	GAS MMBTU/YR	TOTAL MMBTU/YR	TOTAL $	
2	Chilled Water System Modifications	367,567	-24,075	78,558	54,483	276,009	14.02
4	Miscellaneous Thermal Systems Upgrade	345,644	-578	15,720	15,142	60,641	3.05
1	EMCS	672,118	13,983	18,500	32,483	120,193	2.68
3	Electrical	166,651	7,060	-0-	7,060	25,417	1.38
TOTAL		1,551,980	-3,610	112,778	109,168	482,260	-